Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems

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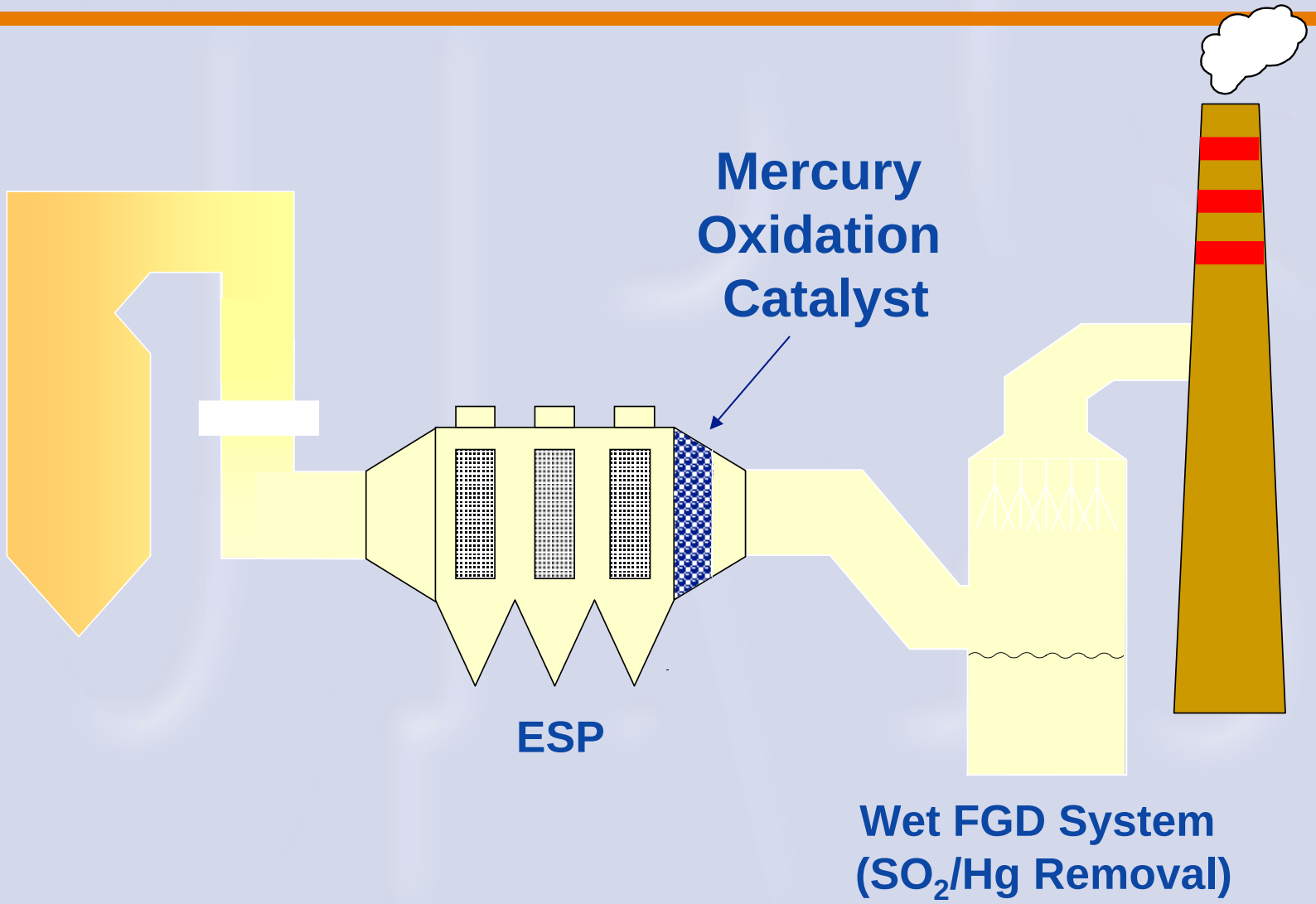
Hg Control Technology Concept

- Catalytic oxidation of Hg^0 in flue gas to increase Hg removal across wet FGD systems
- Development focused on fuel/plant configurations that produce higher Hg^0 percentages in flue gas
- In commercial concept, catalyst would be installed at ESP outlet

Illustration of Process Concept



First Pilot-scale Project

- Conduct pilot-scale tests of honeycomb Hg^0 oxidation catalysts at two sites
  - 4 catalysts tested in parallel (~2000 acfm each)
  - 14-months automated operation at each site
  - Monthly catalyst activity measurements with Hg SCEM
- Host stations:
  - GRE's Coal Creek (ND lignite, ESP, Mg-lime wet FGD)
  - CPS's Spruce Plant (PRB, RGFF, LS wet FGD)

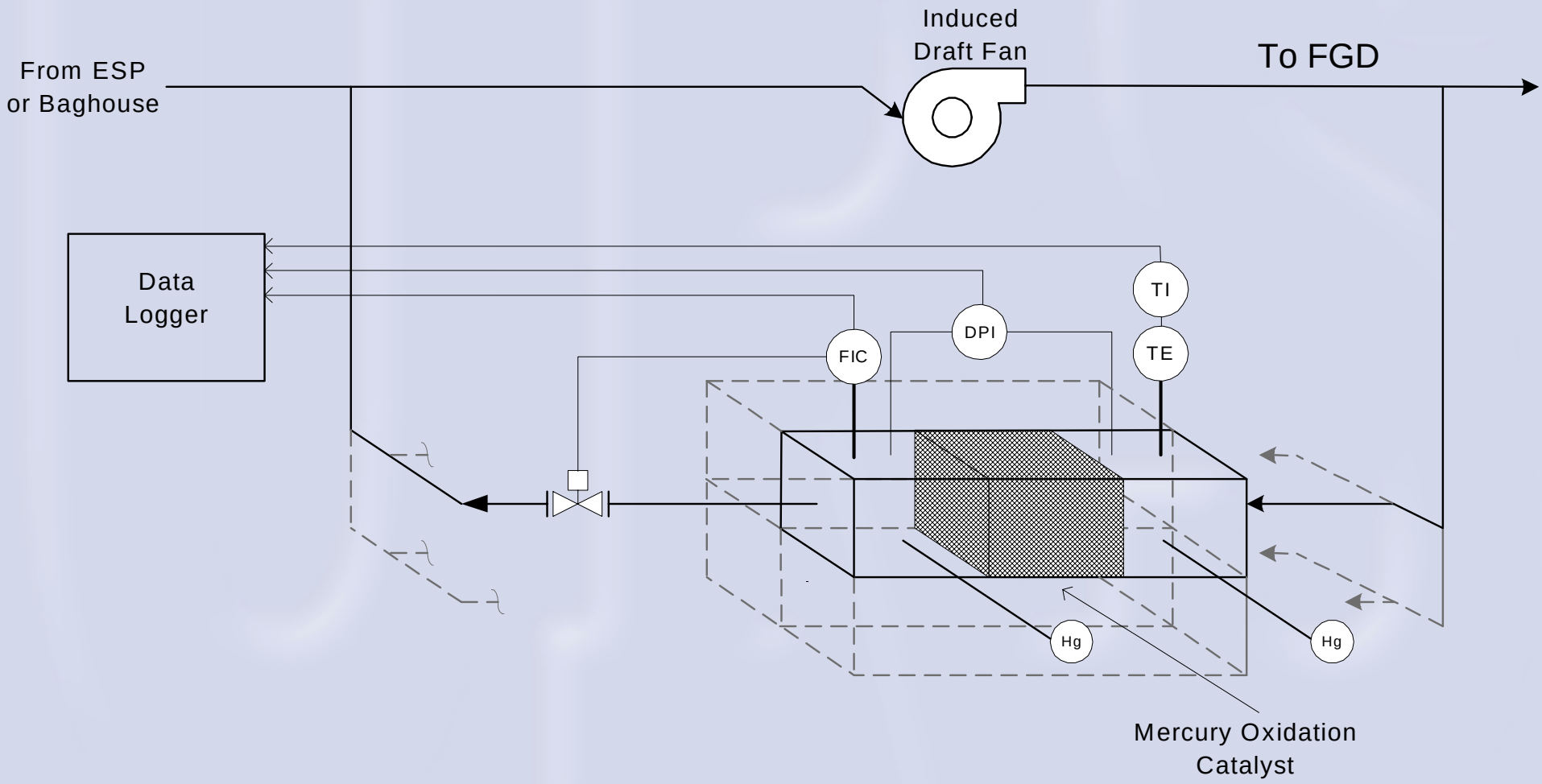
Second Pilot-scale Project

- Use existing pilot units to test Hg oxidation catalysts at 2 new sites starting Fall 04
  - TXU's Monticello Station (TX lignite/PRB, ESP, LSFO wet FGD)
  - Low S Eastern bituminous/ESP site to be determined
- Build and operate new wet FGD pilot unit downstream of oxidation catalysts
  - 2000 acfm inlet flow rate to match one catalyst
  - Conduct short-term wet FGD tests at all 4 sites
  - Test LSFO vs. Mg-lime chemistries

Catalyst Types Tested

- Metal-based
  - Palladium (Pd #1) – All sites
  - Ti/V (SCR) – All sites
  - Gold (Au) – Spruce, Monticello and bit. site
- Carbon-based
  - Experimental activated carbon (C #6) – All sites
- Fly-ash-based – Coal Creek only

Catalyst Pilot Unit P&ID



Hg Oxidation Catalyst Pilot Unit at Coal Creek Station (CCS)

Fly Ash Based Catalyst Module

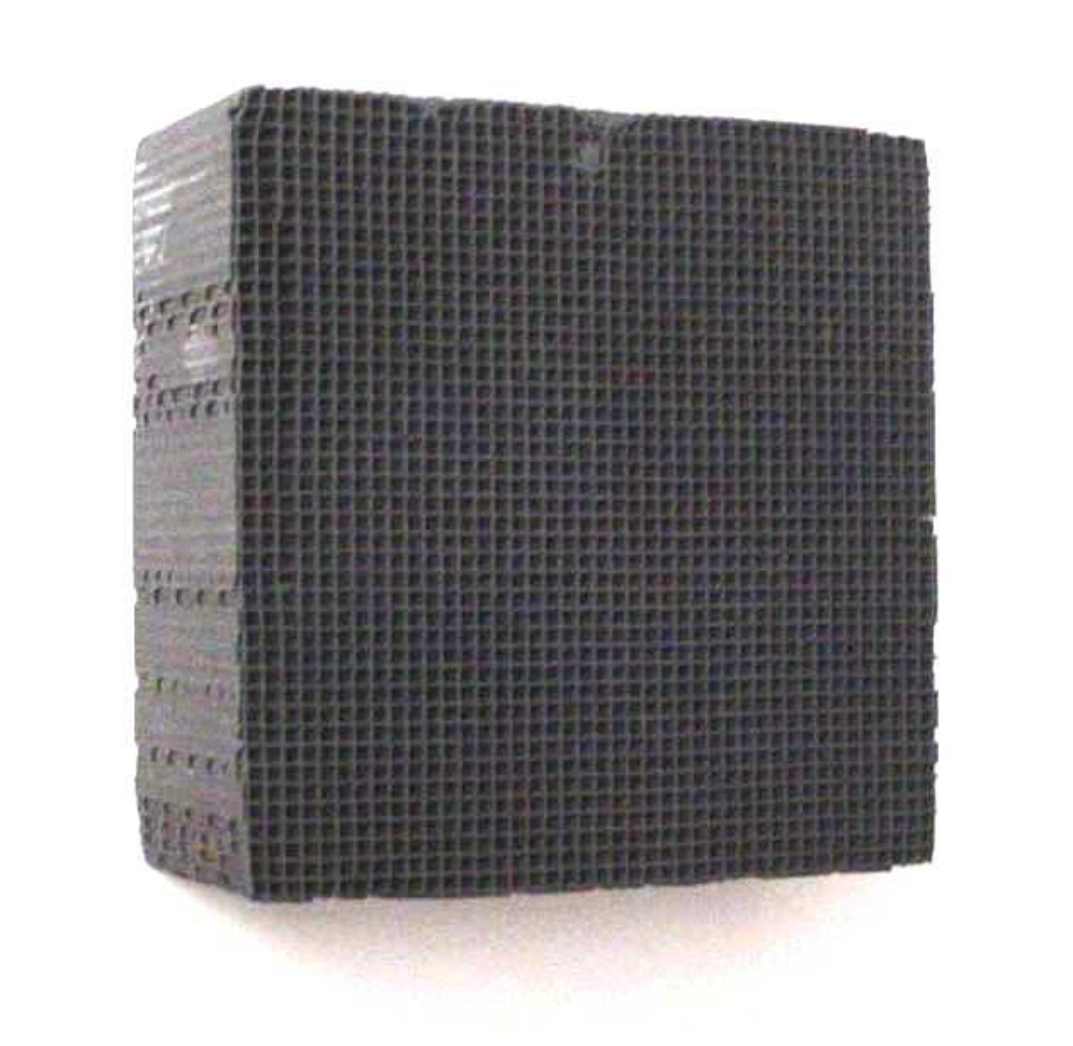
36” x 36” x 3”

One of three per chamber (9” total)

77 cells per square inch

27 sft/hr area velocity

Close-up of One Catalyst Block



Example Catalyst Installation

Pilot Wet FGD Design

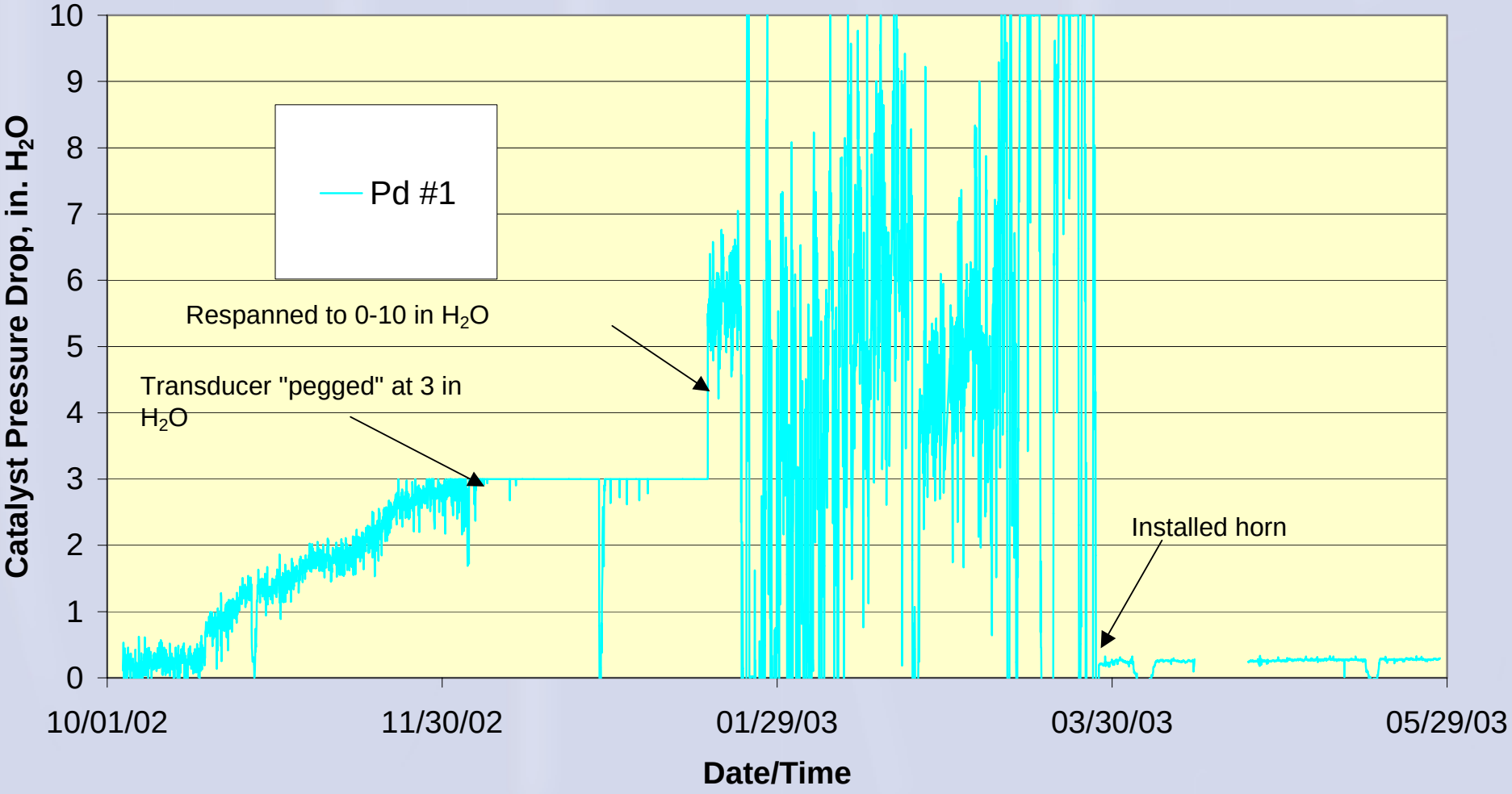
- Alloy absorber, 24-in. diameter, tray contactor
- Adjust L/G to get desired mass transfer
- No dewatering – operates “open loop”
  - Use host site FGD liquor as makeup to get steady-state levels of soluble salts and trace metals
  - At sites w/o FGD spike fresh water with salts to simulate steady-state liquor
- Tests mostly short term (1 to 3 reaction tank residence times)
  - Solids should approach steady state, liquor will not
  - Compromise between cost of testing and information derived

Pilot Wet FGD Skid

First Project Pilot Testing Status

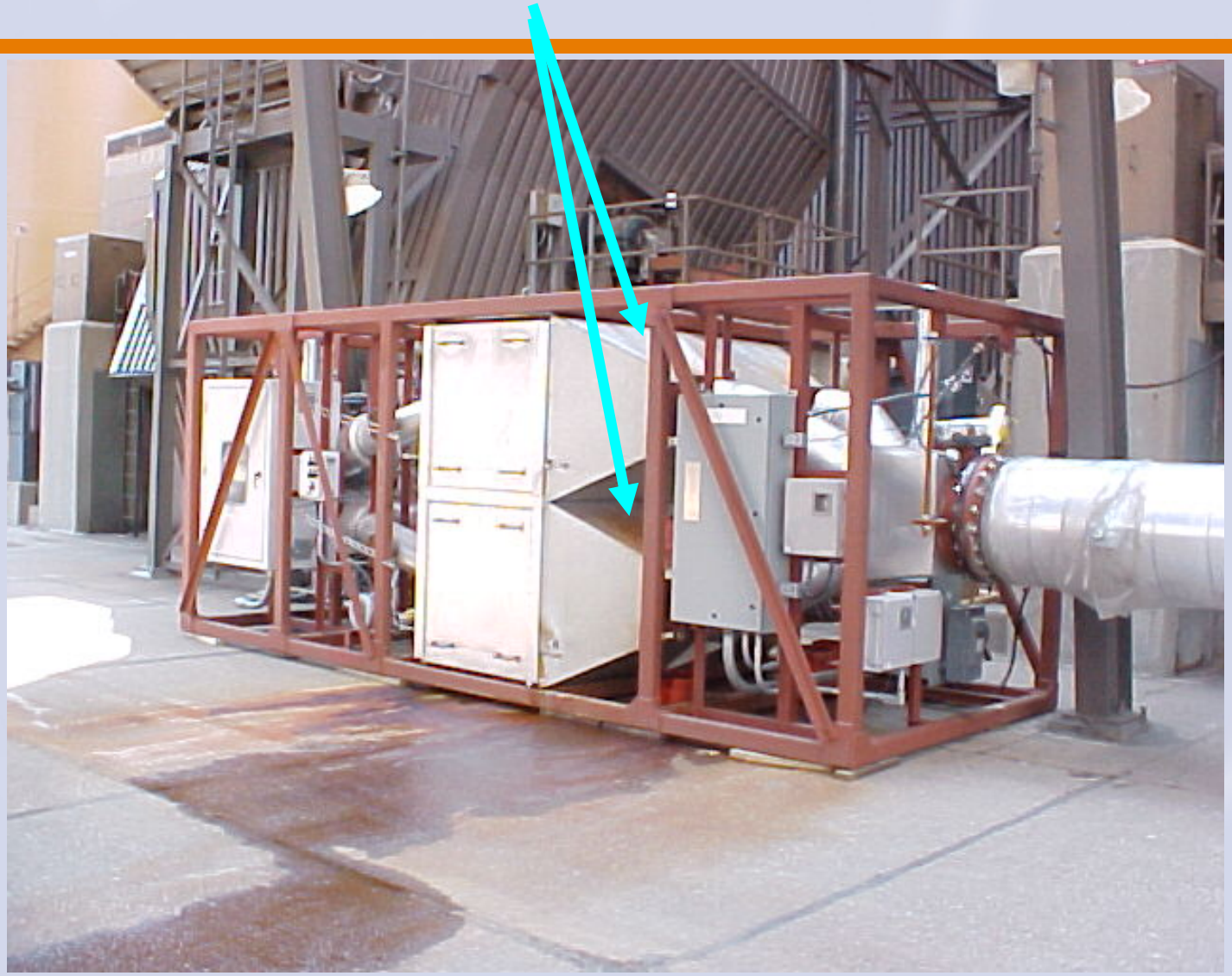
- First pilot unit (Coal Creek):
  - First 2 catalysts installed October 02
  - 3rd catalyst installed December 02
  - 4th catalyst installed June 03
  - FGD pilot & catalyst regeneration tests July 04
- Second pilot unit (Spruce):
  - First 2 catalysts started up August 03
  - Restarted with 4 catalysts after station outage (November 03)
  - Currently operating with same catalysts

Pd #1 Catalyst ΔP through 5/27/03 (shows effect of sonic horn)

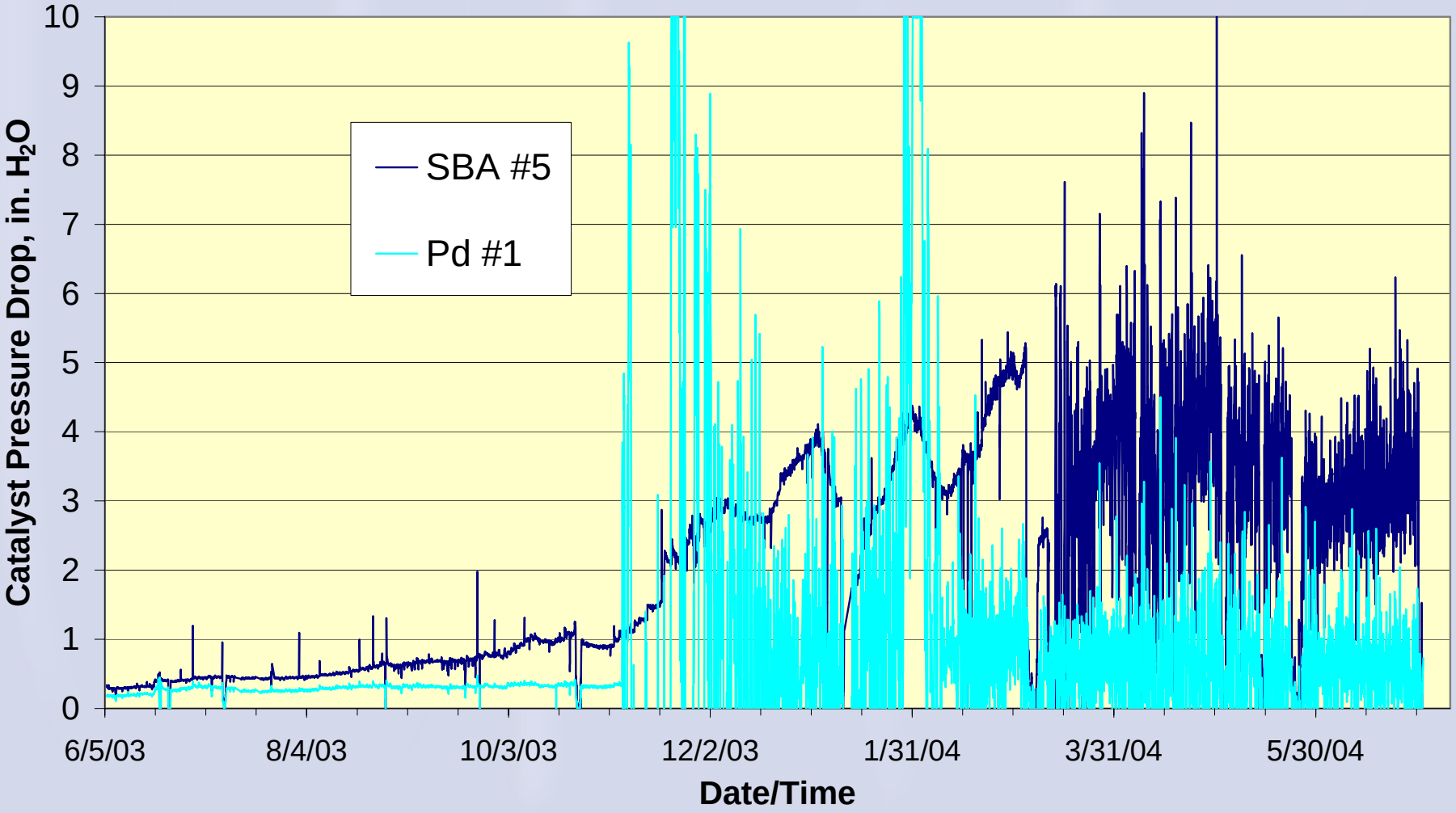


Sonic Horn Installation on Pilot Unit

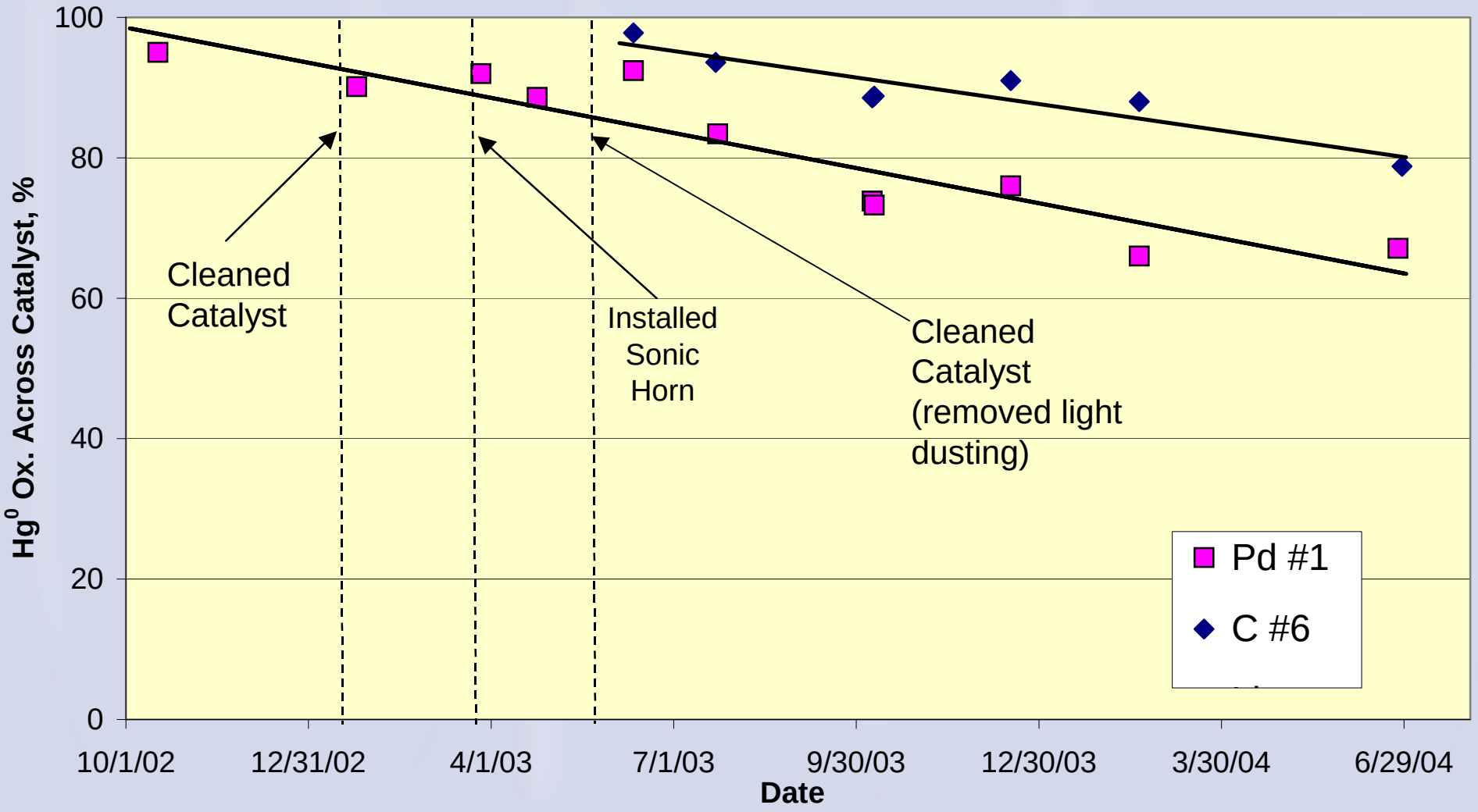
Sonic Horn Locations



Catalyst ΔP since 6/5/03 (sonic horns in all 4 compartments)



Catalyst Activity Trends over 20 Months at Coal Creek



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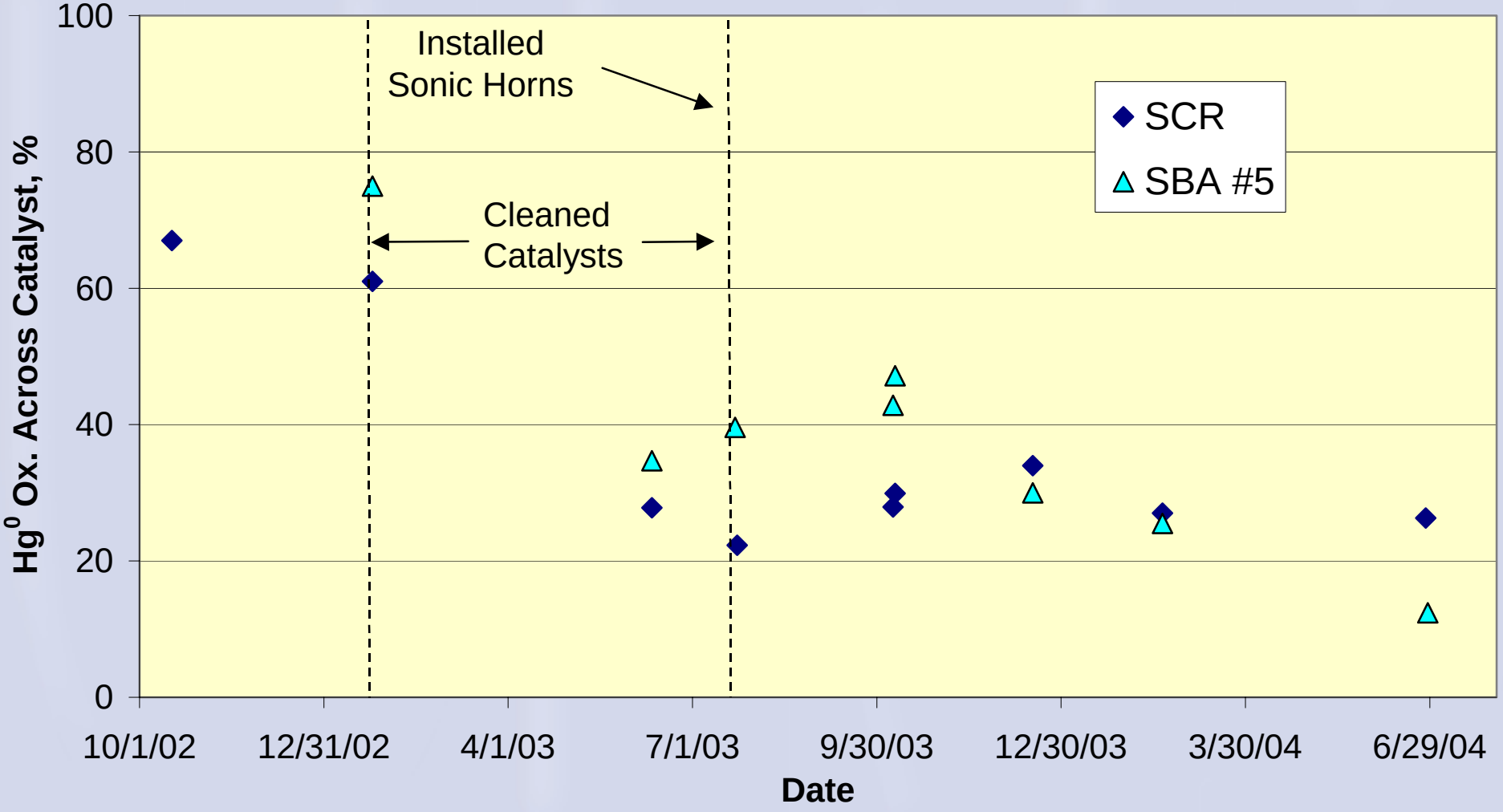


Coal Creek Catalyst Regeneration Test Results

	Catalyst Activity, % Oxidation of Hg^0			
	Fresh Catalyst (10/02)	End of Test (6/04)	Prior to Regen. (7/04)	After Regen. (7/04)
Pd #1	95	67	79	88
SCR	67	26	25	46

Coal Creek Wet FGD Pilot Example Results – C#6/Mg-Lime

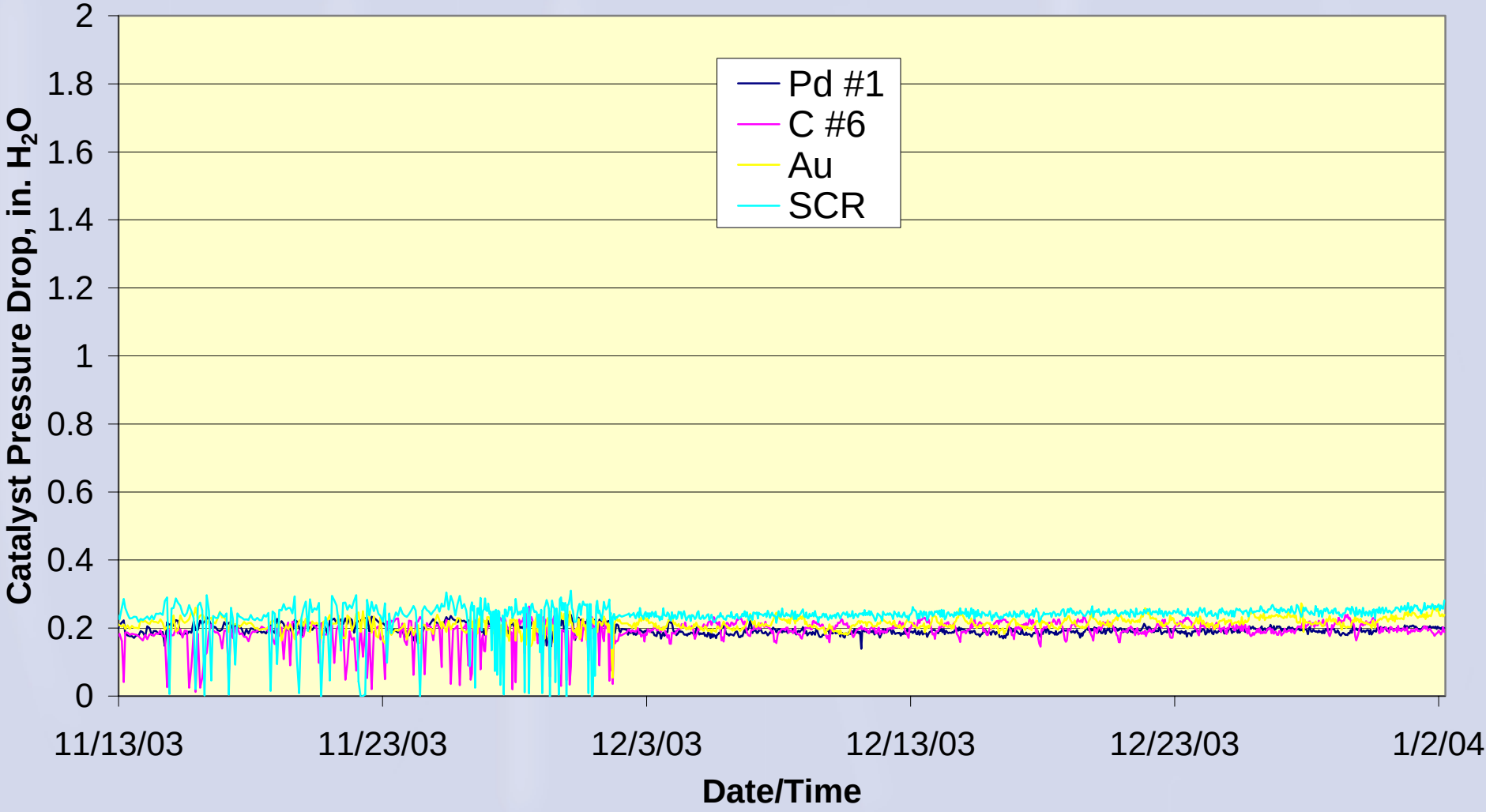
	Total Hg	Hg^0	Hg^{+2}
FGD Inlet ($\mu g/Nm^3$)	18.7	3.65	15.1
FGD Outlet ($\mu g/Nm^3$)	4.25	4.01	0.24
Hg Removal (%)	77	-16	98

Flue Gas Characterization Results

- No effects seen on other flue gas species across catalysts
  - 0.1% or less oxidation of SO_2
  - No oxidation of NO
    - Inlet and outlet NO, total NO_X values agree within <1 ppm
  - No change in HCl (~1 ppm) or HF (~6 ppm) across catalysts

Second Pilot Unit at Spruce Plant

Catalyst Pressure Drop (no sonic horns in compartments)



Pd #1 Catalyst Compartment after 1 Month of Operation

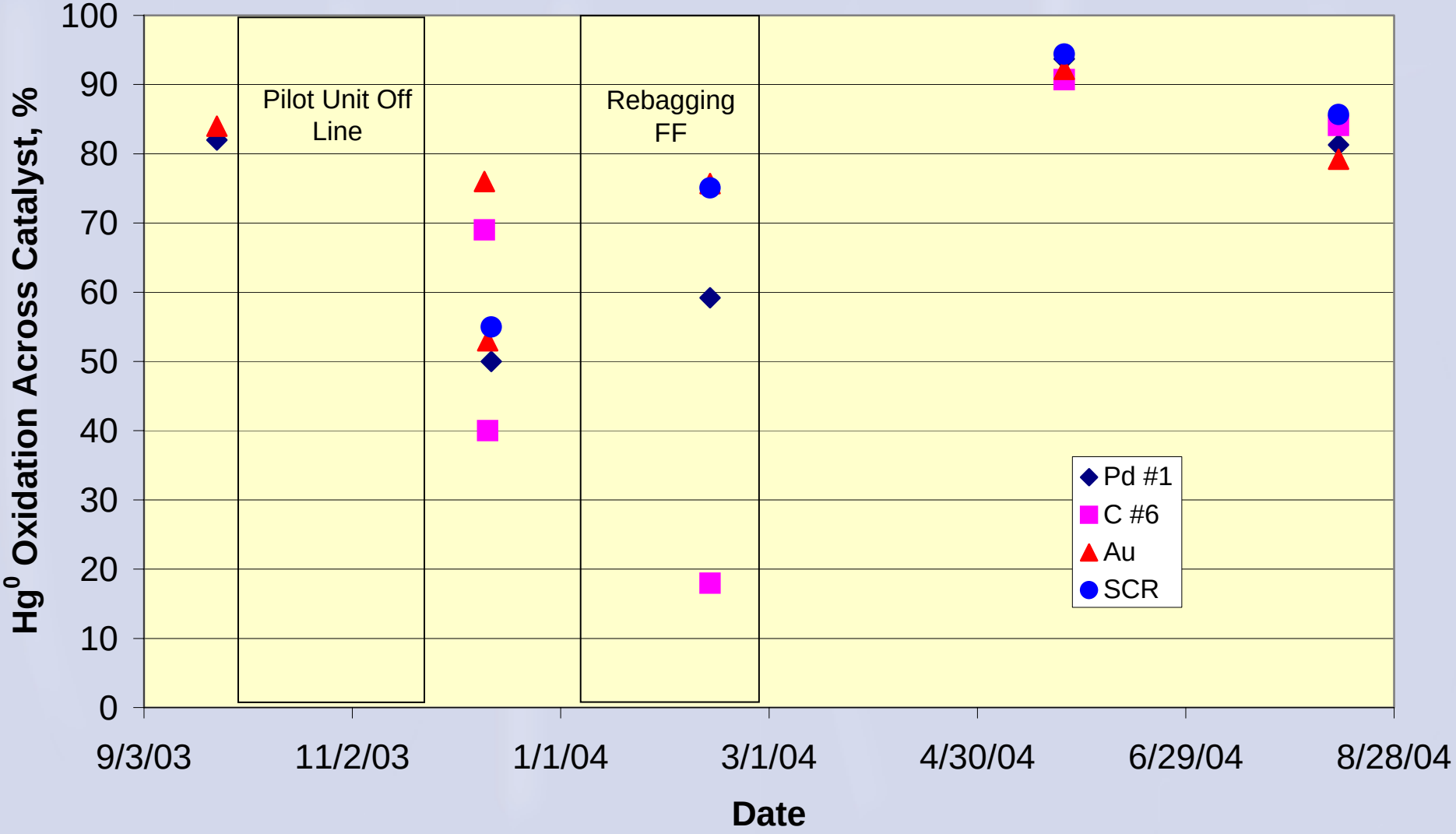
Flue Gas Speciation Results from Spruce (Jan 04, by Hg SCEM)

Location	Hg Conc. (ug/Nm^3)			Overall Hg Ox. (%)	Hg Removal Relative to Inlet (%)	Hg Removal Across Scrubber (%)		
	Hg Total	Hg^0	Hg^{+2}			Hg Total	Hg^{+2}	Hg^0
BH Inlet (7-Jan)	13.5	11.3	2.2	16	-	-	-	-
BH Outlet (6-Jan)	12.7	0.7	11.9	94	6	-	-	-
FGD Outlet (7-Jan)	3.2	1.4	1.8	-	76	75	85	-88

Example Effects of Low Ratio FF for Plants Firing Western Coals

Plant	Configuration	Hg Removal Across FF (%)	Hg Oxidation at FF Outlet (%)
Comanche 2 (ICR)	PC boiler, FF	66	87
Boswell 2 (ICR)	PC boiler, FF	83	80
Intermountain (ICR)	PC boiler, FF, WFGD	34	83
Spruce	PC boiler, FF, WFGD	6-59	75-94

Catalyst Activity Trends at Spruce



Example Recent Spruce Catalyst Activity Data (Hg concentrations in μg/Nm^3)

Catalyst	Inlet Hg_{Total}	Inlet Hg^0	Outlet Hg_{Total}	Outlet Hg^0	% Break-through	% Hg^0 Oxidation
Pd #1 (5/25/04)	10.7	1.89	9.91	0.12	93	94
Pd #1 (8/12/04)	9.66	1.20	9.81	0.22	100	81
C #6 (5/25/04)	10.3	2.01	10.2	0.19	99	91
C #6 (8/12/04)	13.1	1.20	11.5	0.19	88	84

Project Schedule

Complete catalyst regen. at CCS, move pilot unit	Sept 04
Conduct oxidation catalyst pilot tests at Monticello	Oct 04 – Dec 05
Conduct wet scrubber tests at Spruce	October 04
Complete oxidation catalyst tests at Spruce, move pilot	Dec 04 – Jan 05
Conduct oxidation catalyst pilot tests at new site	Feb 05 – March 06

Conclusions

- Sonic horns effective to prevent fly ash buildup
- Pd and C#6 catalysts are most active for Coal Creek ND lignite flue gas
  - Both continually lose activity vs. time
  - Regeneration tests effective for two catalysts tested
  - Wet FGD tests show high removal of oxidized Hg
- All four catalysts are active in Spruce PRB flue gas
  - High Hg^0 oxidation across FF makes activity measurements difficult
- Looking for fourth host site/co-funder!